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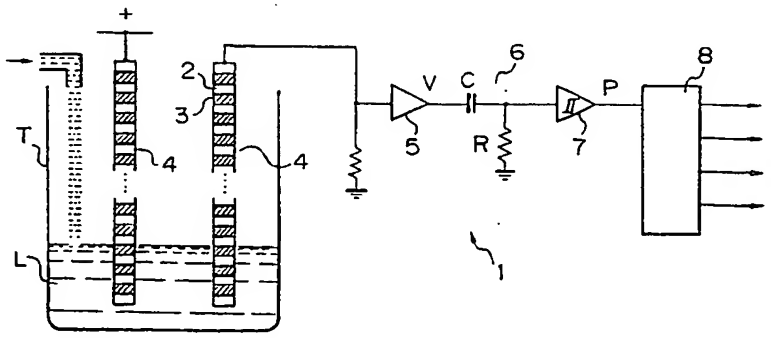
(54) Device for measuring displacement.

(57) A device for measuring displacement comprises a pair of sensor elements (4, 4) of which output voltage changes stepwise in dependence upon displacement of a measurement object, a differentiating circuit (6) for detecting time points at which the output voltage of the pair of sensor elements suddenly changes, and a counter (8) for counting the sudden change time points of the output voltage detected by the differentiating circuit.

Fig. 1



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DEVICE FOR MEASURING DISPLACEMENT

This invention relates to a device for measuring displacement, and more particularly to a device which is useful as a level sensor.

One known form of conventional level sensor consists of a sensor for monitoring the increase of a conductive liquid delivered into a tank.

The known form of level sensor comprise a pair of sensor elements each having electrode portions and resistor portions formed one after another which are provided within the tank wherein the electrode portions are adapted so that they can come into an electrical contact with a liquid in order to detect a change in the liquid level. The resistor portions are coated on their surfaces with an insulating material so that they do not come into an electrical contact with the liquid.

The power supply voltage is delivered to one sensor element. The other sensor element is connected to a buffer amplifier and is grounded through a resistor from the junction of the other sensor element and the buffer amplifier.

In the level sensor thus constructed, an input voltage of the buffer amplifier rises stepwise with rising of the liquid level.

An output voltage of the buffer amplifier is inputted to a large number of comparators connected in parallel and is compared with reference voltages at respective comparators.

The reference voltages of the comparators are set so that they have potentials slightly lower than step potentials of the output voltage of the buffer amplifier, respectively.

Thus, as the level of the liquid rises, outputs of respective comparators shift to "H" level in order from the comparator having the lowest reference voltage to comparators having higher reference voltages.

Outputs from respective comparators are inputted to a priority encoder, in which they are converted to binary codes, respectively.

An output from the priority encoder is inputted to, e.g., a display or a microcomputer, etc.

Thus, any change of level of the conductive liquid delivered to the tank is monitored.

Since the characteristics of the sensor elements can deteriorate because of contact with the liquid, it is necessary to exchange them, fairly frequently.

However, because the resistor portions of the sensor element have unevenness, the characteristic is changed by the exchange of the sensor element. In particular, when a sensor element is exchanged, the characteristic of the output voltage of the buffer amplifier does not necessarily show a step potential slightly higher than the reference voltage of each comparator.

Thus, it is inconvenient to use the previously determined reference voltages, so new reference voltages must be set, resulting in the problem that such a setting is troublesome.

Accordingly, it is an object of the present invention to provide a device for measuring displacement constructed so that no error is produced even if there is unevenness in the characteristic of the sensor element.

According to the present invention there is provided a device for measuring displacement, including displacement sensor means of which output voltage changes stepwise in dependence upon a displacement of a measurement object, differentiating means for detecting time points at which the output voltage suddenly changes, and counter means for counting the sudden change time points of the output voltage detected by the differentiating means.

Thus with the device for measuring displacement according to this invention, the sudden change time points of the output voltage of the displacement sensor means is detected by the differentiating means and is counted by the counter means, and displacement is measured by the counted value.

Accordingly, even if the output voltage of the displacement sensor means becomes uneven by unevenness thereof, no influence is exerted on the measured results, giving no error.

The present invention will now be described in greater detail by way of examples with reference to the accompanying drawings wherein:

Fig. 1 is a diagrammatic view showing the configuration of a level sensor forming a first embodiment of a device for measuring displacement according to this invention;

Fig. 2(a) is a graph showing an output voltage V of the buffer amplifier shown in Fig. 1;

Fig. 2(b) is a waveform diagram showing an output signal P of the Schmitt trigger circuit show in Fig. 1;

Fig. 3 is a diagrammatic view showing the configuration of a level sensor forming a second embodiment of a device for measuring displacement according to this invention;

Fig 4(a) is a graph showing an output voltage v of the buffer amplifier shown in Fig. 3;

Fig. 4(b) is a waveform diagram showing an output signal PP of the Schmitt trigger circuit shown in Fig. 3; and

Fig. 4(c) is a waveform diagram showing an output signal NP of the Schmitt trigger circuit shown in Flg. 3.

Referring to Fig. 1, there is shown a level sensor 1 which is an embodiment of a device for measuring displacement according to this invention.

In the same manner as in the conventional level sensor, this level sensor 1 serves to monitor how a conductive liquid L within a tank T increases.

A pair of sensor elements 4, 4 each comprised of electrode portions 2, and resistor portions 3 formed in altematic sequence are provided within the tank T . Such construction is the same as that of the conventional level sensor.

Further, a buffer amplifier 5 has also the same configuration as that of the conventional buffer amplifier.

An output voltage V of the buffer amplifier 5 is delivered to a differentiating circuit 6 comprised of a capacitor C and a resistor R

An output from the differentiating circuit 6 is delivered to a binary counter 8 through a Schmitt trigger circuit 7.

In the above construction, when the level of the liquid L rises, so an output voltage V of the buffer amplifier 5 rises stepwise, an output signal P of the Schmitt trigger circuit 7 takes a form of pulse at each time point when the step varies.

The counter 8 counts the number of pulses delivered thereto. Respective counted values are outputted in the form of binary codes.

As shown in FIG. 2(a) , it is assumed that the characteristic changes when a sensor element 4 is exchanged because of unevenness of the sensor element 4, so that output voltage V of the buffer amplifier 5 changes from a indicated by the solid line to β indicated by the dotted line.

As shown in FIG. 2(b), since the output signal P of the Schmitt trigger circuit 7 becomes the same signal even in the case of the characteristic α or in the case of the characteristic β , any change is not produced in a measured result obtained as an output of the counter 8.

Namely, any error due to unevenness of the sensor element 4 is not produced.

As described above, since this level sensor 1 is constructed to measure displacement by changes in an output voltage of the sensor element, no error is produced even if there is unevenness of the characteristic of the sensor element. For this reason, even if the sensor element 4 is exchanged, any adjustment becomes unnecessary.

It is to be noted that while an approach is only employed in the above-described embodiment to monitor that an output voltage V of the buffer amplifier 5 rises stepwise, a more improved approach as in a level sensor 11 shown in FIG. 3 may be adopted.

Namely, a differentiating circuit 16 capable of outputting a negative differential pulse NP is used in addition to the differentiating circuit 6, and an up-down counter 18 that operates to discriminate between positive and negative differential pulses PP and NP to perform countup and countdown opera tions is used. Thus, since the counter 18 performs up and down operations in dependency upon increase and decrease in the output voltage V of the buffer amplifier 5, it is possible to monitor that the level of liquid L rises and falls.

In FIG. 3, reference numeral 17 denotes an inverting input type Schmitt trigger circuit connected to the output terminal of the differentiating circuit 16.

As shown in FIG. 4(a), it is assumed that the characteristic changes when a sensor element 4 is exchanged because of unevenness of the sensor element 4, so that output voltage V of the buffer amplifier 5 changes from α indicated by the solid line to β indicated by the dotted line.

As shown in FIG. 4(b), since the output signal PP of the Schmitt trigger circuit 7 becomes the same signal even in the case of the characteristic α or in the case of the characteristic β , any change is not produced in a measured result obtained as an output of the up-down counter 18.

As shown in FIG. 4(c), since the output signal NP of the invering input type Schmitt trigger circuit 17 becomes the same signal even in the case of the characteristic α or in the case of the characteristic β , any change is not produced in a measured result obtained as an output of the up-down counter 18.

Claims

1. A device for measuring displacement including:
displacement sensor means (4,4) of which the output voltage changes stepwise in dependence upon displacement of a measurement object;
differentiating means (6,16) for detecting time points at which said output voltage suddenly changes; and
counter means (8, 18) for counting the sudden change time points of said output voltage detected by said differentiating means.

2. A device for measuring displacement according to claim 1, wherein said differentiating means consists of a differentiating circuit (6, 16) operative to output positive and negative differential pulses (PP, NP), and wherein said counter means consists of an up-down counter (18) operative to perform an up-count operation and a downcount operation in dependence upon the positive and negative differential pulses inputted thereto.

3. A device for measuring displacement according to claims 1 or 2, wherein each sensor

means (4, 4) is composed of electrode portions (2) and resistor portions (3) formed in alternate sequence.

4. A device for measuring displacement according to any one of the preceding claims, wherein said differentiating circuit (6,16) includes a buffer amplifier (5) and at least one Schmitt trigger circuit (7, 17).

Fig. 1

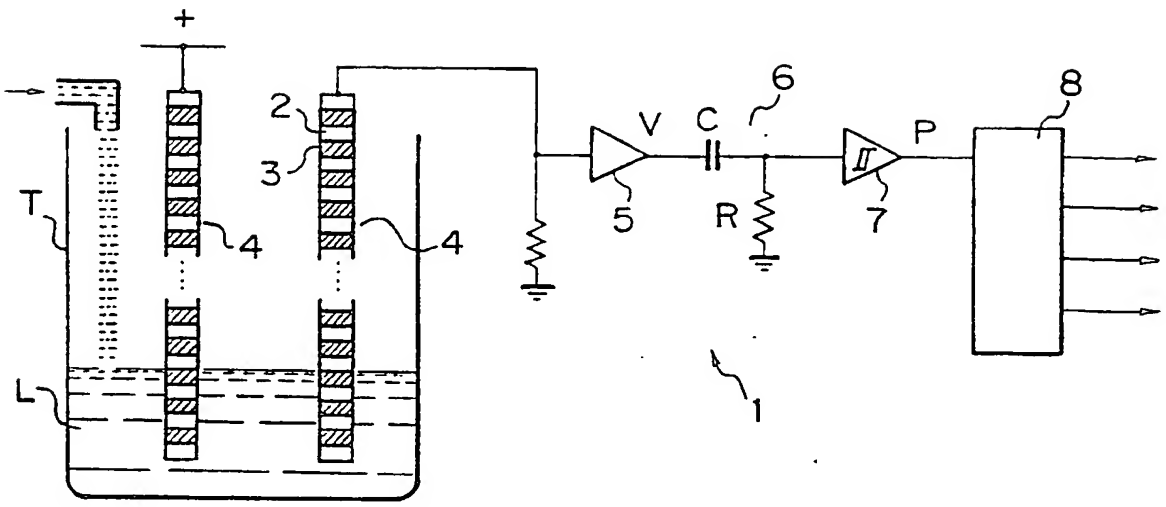


Fig. 2

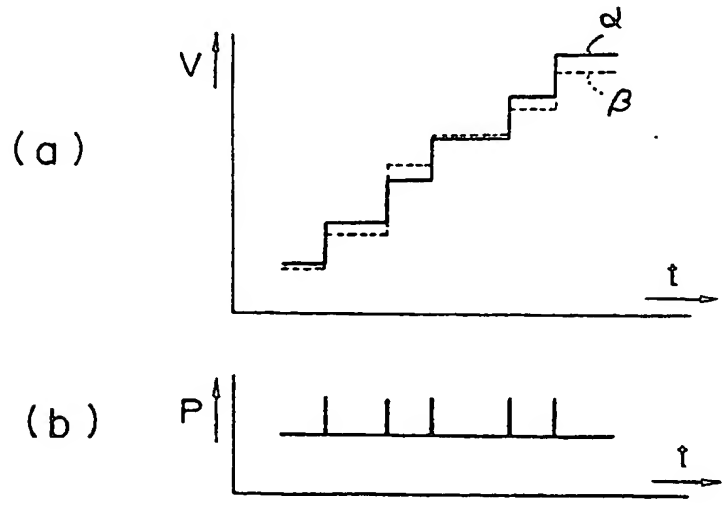


Fig. 3

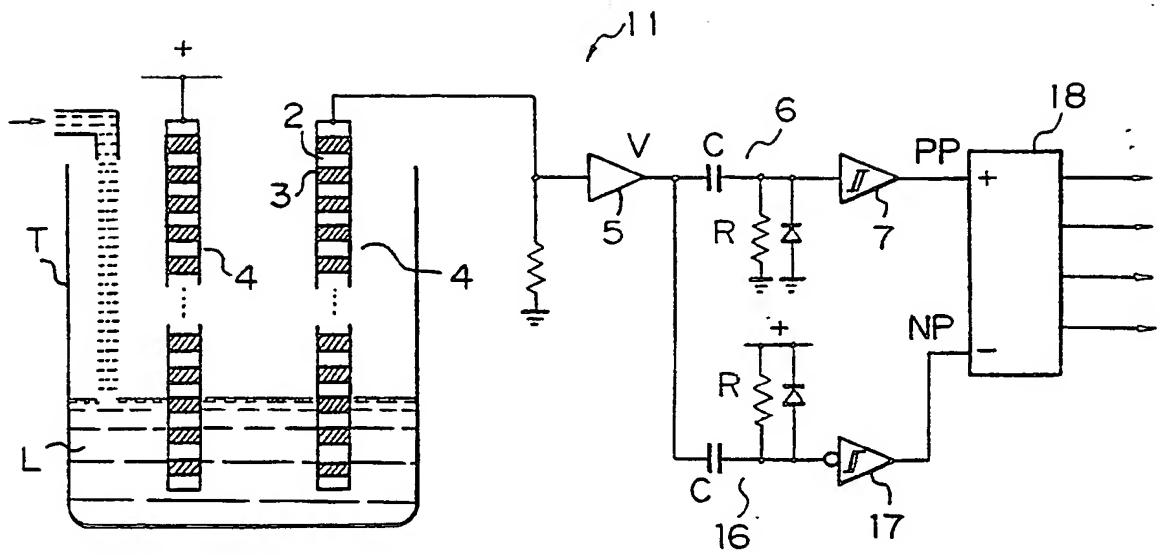
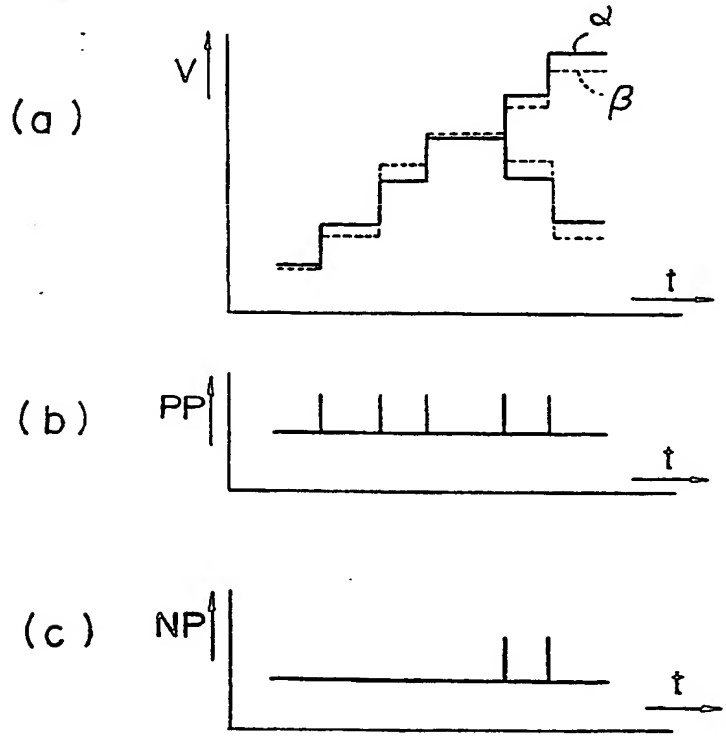


Fig. 4



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EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 90306613.2

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 5)
X	US - A - 3 943 767 (EFFERSON) * Column 3, line 9 - column 4, line 13; fig. 3,4 *	1,2,4	G 01 F 23/24
A	DE - A1 - 3 114 678 (POLITECHNIKA WROCLAWSKA) * Pages 5,6; fig. 1 *	1,3	
A	DE - A1 - 3 330 981 (SCHITTEK) * Page 4; fig. 1 *	1,3	
A	US - A - 4 390 793		TECHNICAL FIELDS SEARCHED (Int Cl 5)
A	US - A - 4 749 988		G 01 D 5/00 G 01 F 23/00 G 05 D 9/00 G 08 B 21/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	13-09-1990	BAUER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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